

Risk Management of Refuel Outages

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Forum 2000
16-20 October 2000

Obninsk, Russia

- Background of MNGP
- Current PSA Model
- Future PSA Model
- Outage Risk Assessment Report
- Outage Risk Management Meeting
- Communication of Risk Information
- Examples from January 2000

- GE BWR-3
- 1775 MW_t 613 MW_e
- Commercial Operation: June 30, 1971
- Plant Located 45 miles NW of Minneapolis, Minnesota, USA

Current PSA Model

- Modify 100% Power Model
- EPRI Risk and Reliability Workstation - CAFTA
- SETS
- Shutdown event trees solved to force desired equipment into cutsets.
- Schedule divided into about 8 segments

Outage Segment Considerations

- Reactor Head on or off
- Reactor Water Level
- Fuel Pool Gates
- Decay Heat decreases with time
- Equipment out of service
- Recovery Factors - decay heat, water level and temperature, fuel pool gates

Future PSA Model

- EPRI Risk and Reliability
Workstation - CAFTA, etc.
- EPRI Risk and Reliability
Workstation - EOOS
- PSA quantified within EOOS for
each case (generate new cut sets
for each study)
- Scheduling and Operations use
same tool for shutdown as
operating

Outage Risk Assessment Report

- Results
- Make-Up Requirements
- Time to Boil / Uncover Fuel
- Segment by Segment Details
 - Reactor Water Level, etc.
 - Unavailable Equipment
 - Description of Segment
 - Dominant Contributors to Risk
- Emergent Work

Outage Risk Management Meeting

- **Multi-Disciplinary Team** - Scheduling, Operations, PRA, Engineering, Radiation Protection, Chemistry, Training
- **Review Outage Risk Assessment Report Segment by Segment**
- **Review NUMARC 96-01** - concentrates on which systems available for key safety functions instead of systems out of service
- **Review Fire Protection**
- **Schedule finalized after meeting**
- **Additional meetings if significant schedule changes**

Communication of Risk Information

- Outage Risk Assessment report sent to MNGP Management and Outage Risk Management Team
- Schedule discussed with NRC Resident Inspector
- Risk information announced at Outage meetings which are held twice daily
- Operations or scheduling report emergent work to PRA
- PRA attends outage meetings to make sure aware of emergent work

Example Page from Outage Report

Reactor Segment 3

Start Date: January 9	71 hours after shutdown	Outage Days: 4-14	
Rx Level: Flooded		Rx Temp: 90°F	
Rx Head: Off		FP Gates: Out	
Time to Boiling (hr): 28	Probability of Boiling (per day):	6E-6	
Time to Damage (hr): 190	Probability of Damage (per day):	8E-9	Green

Significant Equipment Unavailable:

<u>Division I</u>	<u>Division II</u>	<u>General</u>
250V DC / Y-71	EDG	RWCU
Cond / FW	EDGESW	CRDH
RCIC	4kV AC Bus 12, 14, & 16*	RBCCW**
	250V DC / Y-81	
	Core Spray	
	RHR	
	LPCI	
	RHRSW	
	Cond / FW	
	HPCI	

Description:

Segment 3 begins when the reactor cavity is flooded, fuel pool gates are removed, and condensate / feedwater system can be removed from service. At the same time (0200 on January 9), division I ECCS is returned to service. Shutdown cooling is shifted from division II to division I prior to removing division II of RHR from service. Division II 125V DC power is available, as supplied from division I 125 V DC. RBCCW pump A is removed from service for maintenance, but the system remains functional.

The fuel shuffle does not begin until day 12, so very little fuel is transferred to the fuel pool during this segment. Transformer 1R continues to be unavailable the majority of segment 3. Once 1R is returned to service, transformer 1AR is removed from service. The times to boiling and core uncover increase dramatically because of the large amount of water in the flooded cavity. This results in a decrease in risk of fuel damage and boiling, which offsets the increased risks resulting from equipment being removed from service.

* LC-104 is cross-tied to LC-103.

** RBCCW pump A is out of service for maintenance. Model reflects reduced system reliability.

- dominant contributors to the risk of fuel uncover include:

- failure of EDG 11 (and failure to recover)
- loss of offsite power (and failure to recover)
- small LOCA

- dominant contributors to the risk of boiling include:

- loss of shutdown cooling (and failure to recover)
- failure of RBCCW pump (other pump OOS for maintenance)

Guidelines For Emergent Work

Does the emergent work add, increase the duration of, or move a system window for any of these systems?

RHR - Shutdown cooling or LPCI function
RWCU (alternate shutdown cooling)
Core Spray
Torus (as a source of suction for ECCS)
Condensate
Feedwater
Condenser (source of makeup)
RHRSW
Fire Protection
Condensate Service Water
Condensate Storage Tanks
Service Water
RBCCW
CRD Hydraulic System
Fuel Pool Cooling (including alternate cooling with RHR)
Instrument Air
Emergency Diesel Generators
Diesel Generator #13
EDG-ESW
AC or DC distribution
Substation (less than 2 sources of offsite power)
Additional systems when RPV head is on:

- Condenser (RPV Pressure Control)
- Torus (RPV Pressure Control)
- HPCI
- RCIC





